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The Forest Tent Caterpillar

SECOND REPORT

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AGRICULTURAL EXPERIMENT STATION

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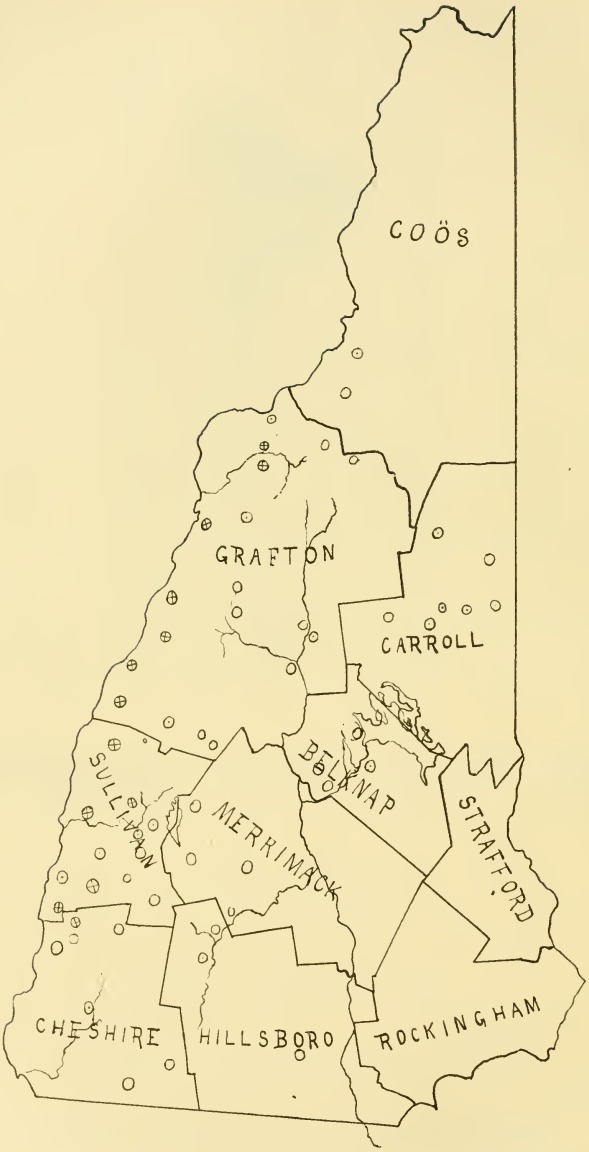

FIG. 37.—Distribution of Forest Tent Caterpillar in New Hampshire, 1899.

Circles, caterpillars present; circles with dot, rather destructive; circles with cross, very destructive.

THE FOREST TENT CATERPILLAR

BY CLARENCE M. WEED

FIG. 38.–Cocoon in Barberry Leaves.

The outbreak of the Forest Tent Caterpillar in New Hampshire in 1899 was more widespread and serious than during any previous year of which we have record. A very great amount of damage was done to maple sugar orchards, shade trees, and apple orchards, as well as to the general forest growth; and eggs were laid for a 1900 brood of worms, which, in many localities, at least, threatens to be equally destructive. The present bulletin is issued to furnish the people of the state with the latest available information regarding the pest, both as to its habits and life history, and as to the means of combating it. In the bulletin I have embodied the results of the observations made last season by myself and my assistant, Mr. W. F. Fiske, as well as several valuable observations kindly communicated to me by Miss Caroline G. Soule, who studied the insect at Brandon, Vermont, and the notes of more than one hundred correspondents who kindly replied to a circular letter I sent out. A few of the paragraphs are reprinted without important change from Bulletin 64, issued a year ago.

DISTRIBUTION IN 1899

The localities in which these caterpillars were destructive last season are indicated in the map on the inside front cover of this bulletin. The circles with a cross inside indicate places

of very serious damage; those with a dot inside, less serious damage, and the simple circles, places where the insects were numerous enough to be noticed by our correspondents, but were not very destructive. It is likely that many of these latter places will have the insects in greater numbers this season.

An interesting fact brought out by the preparation of this map is that the insects seem to follow rivers closely in their spread from one locality to another. The injury has been most severe along the Connecticut river, where the insects first appeared in destructive numbers about four years ago.

THE LIFE HISTORY OF THE INSECT

These Forest Tent Caterpillars pass the winter within the eggshell, the eggs being attached to the twigs in cylindrical rings, more or less covered with a grayish varnish. In spring, when the leaves of the trees begin to unfold, the young caterpillars gnaw through the eggshells and come forth. They are then tiny creatures, scarcely one tenth of an inch long, showing under a lens that the blackish body is thickly covered with rather long brownish, or grayish, hairs. The tiny caterpillars feed upon the tender leaves of the twig near where the egg-mass was placed. In about two weeks each increases in size to such extent that the skin in which it came from the egg is too small for it. This skin

FIG. 39.—Cast skins of Forest Tent Caterpillars.

FIG. 40.—A mass of Caterpillars on the trunk of a crab-apple tree.
(Photographed by Dr. F. W. Russell.)

then splits open along the back, and the caterpillar crawls out, clad in a new skin that had gradually been forming beneath the old one. This skin-shedding process is called moulting: it is the general way in which insects provide for increase in size. Some of the cast skins are shown in Fig. 39.

Wherever they go, these little larvæ spin a silken thread which marks their pathway, although the thread is so slender that a single one is generally to be seen only through a lens, but in places where the larvæ congregate to rest when not feeding, a habit that they have, it becomes quite noticeable. It is especially so after moulting, for then one can often find on the end of a forked twig such a miniature tent as is represented in the picture on the title page of this bulletin, the cast skins being intermingled with the silken threads.

Soon after the first moult the caterpillars begin feeding again, eating, of course, more and more of the foliage as they become larger. A week or so later they again moult, a process which is repeated twice, thereafter, at similar intervals. At the time of the later moults, the caterpillars are in the habit of congregating upon the trunks or larger limbs of the tree, often not far from the ground. Beneath the mass of larvæ there is an inconspicuous web, in which the feet are more or less entangled. The appearance of the caterpillars at such times is well shown in the photograph reproduced in Fig. 40. At the end of about five weeks from the time of hatching from the egg, the Forest Tent Caterpillars become full grown in this,

Fig. 41.—Cocoons in Apple Leaves.

their larval state. They are now ready to enter upon the next stage of their existence, that of the pupa, or chrysalis. This is a quiet stage, in which the insect takes no food, and is unable to move about, and it needs to protect itself from its various enemies. Consequently, each caterpillar spins from certain silk glands in the mouth a shroud of silken threads, surrounding itself by an oval cocoon composed of several layers of silk, the outer ones much looser than the inner, with the hairs of the caterpillar intermingled with the silk on the inside layers. When this cocoon is first spun it is white, but the caterpillar soon colors it yellow with an excretion from the body. The caterpillars generally prefer some sort of frame-work to build their co-

FIG. 42.—Cocoon in Currant Leaves.

FIG. 43.—Cocoon on Fringe-tree.

coons upon. They commonly choose the leaves of trees for this purpose. Sometimes a single large leaf will be used, its edges being folded over, as in the case of the cocoons in apple and currant leaves, shown in Figs. 41, 42 and 48, while, at others, several smaller leaves may be deftly drawn together, as in the barberry leaf cocoon shown in Fig. 38. If the insect happens to be in a pine tree it will utilize the pine needles for this purpose, and even such delicate structures as the panicles of the smoke bush or fringe tree may serve the purpose. (Fig. 43.) Where the caterpillars are numerous, the foliage of the trees is almost wholly webbed up when the cocoons are made, giving the trees a strange, bunchy appearance. Many of the caterpillars, however, leave the trees, and seek shelter in other situations, such as crevices in the rough bark, beneath boards or stones upon the ground, in the crannies of a fence, along the clapboards or beneath the gables of buildings.

Wherever the cocoon is spun the caterpillar inside of it soon changes to a pupa or chrysalis—an oval brown object without

a *b*

FIG. 44.—Moths of Forest Tent Caterpillar; *a*, male; *b*, female. Natural size.

legs or wings, able to move only by a feeble wriggle of its body. In this condition it takes no food, but its tissues undergo such remarkable changes that about ten or twelve days after the cocoon is made, a buff-brown moth emerges from the chrysalis and makes its way through one end of the cocoon. This is the adult form of the Forest Tent Caterpillar. The male moths are slightly smaller than the females, as may be seen from Figs. 44 *a* and *b*, the first of which represents the male and the second the female, both natural size.

The moths generally make their appearance the latter part

of June. Soon afterwards the females deposit their eggs in masses of about two hundred, each upon the twigs. The moths, having completed the cycle of life, die soon after the eggs are laid.

The eggs thus deposited early in July are to remain unhatched until the following spring. The actual formation of the tiny caterpillars from the contents of the egg takes place, however, within a few weeks after they are laid. The minute but fully-formed caterpillars may be found within the egg shells, by a careful examination, any time between September and the following April. The caterpillars remain during this long period quietly confined within their narrow houses, but when the warmth of the spring sunshine penetrates their abodes, they eat off the tops of the egg shells, and come out ready to break their long fast upon the tender foliage of the opening buds.

As a result of much patient watching, Mr. Fiske was fortunate enough to observe one of the moths depositing her eggs. He has recorded his observations in his notes as follows:

On the afternoon of June 27, three pairs of freshly-emerged Clisiocampa disstria moths were found in the breeding cages mating, and two of them placed, without separating, under a bell jar with some green twigs of apple. At 8 p. m. one pair had separated, and the female was very active, buzzing around the interior of the bell jar. Fifteen minutes later she had taken notice of the apple twigs, and was more slowly crawling over them. By 9 o'clock she had selected a site for an egg ring, and had just begun its deposition. About a dozen eggs were laid at this time, in the form of a right triangle, one side forming what was to be one edge of the future egg ring. On what would correspond to the hypothenuse of this triangle she was now busy depositing more eggs, making each row longer and increasing consequently the width of the future band, still keeping the general form of the egg mass the same. The placing of the first egg in each row is accomplished with some difficulty, and is also a matter of some delicacy, for if it is not placed correctly, the whole band may suffer; but after this is done, the remainder are easily fixed in their proper positions, the abdomen, which is stretched nearly to its limit, so moving that each egg slips into the space between the end egg on the row under construction, and the corresponding egg in the row just completed. The eggs are laid at intervals of about half a minute, and after each is deposited there is a second's pause, followed by a little pile of bubbles of creamy whiteness, which rise around it and help to form the tough, protecting winter coat. It is very difficult to get a good view of the operation at close hand, on account of

the position in which the wings of the moth are held, drooping and well covering the abdomen, and it cannot be stated with certainty whether the egg itself is deposited just before or just after the extrusion of the froth.

The width of the band being decided upon, the rows are made of uniform length thereafter and the girdle begins to take form. In the case under observation, as the moth was undersized the band was a narrow one, and the number of eggs in each row was about seven. When the band was nearly completed, after about an hour's work, the moth was disturbed, and for the remaining distance the rows were anything but regular. Whether as a result of this break or otherwise, there were a lot of eggs left over after the ends of the band were united, and these were deposited slowly and irregularly, with much preliminary feeling about on the lower edge of the band. This part of the operation required above an hour, or as long for the placing of a few dozen eggs as it did for the construction of the girdle proper. The whole time, from the first observation until the egg mass was finally left, was about two and a half hours. The moth did not long survive the completion of the ring, but within a few hours, before it had been a whole day in its perfected form, it died.

A condition that has been repeatedly noticed during the last three years seems to indicate that in general the instinct of the moth teaches it to deposit eggs only on trees bearing leaves at the time the eggs are laid. When a maple orchard is defoliated one year, it is likely to escape the next year, unless it is invaded by caterpillars hatched on the surrounding trees. The moths that develop on such a lot of defoliated trees apparently fly to the surrounding trees that still bear leaves before depositing their eggs. Of course this habit is of advantage to the insect, for the chances of a sufficient food supply for the caterpillars are greatly increased by it. In some cases, however, the explanation is that the caterpillars completed the defoliation of the trees before they were full grown, and then migrated to new feeding grounds.

THE POPULAR NAME OF THE INSECT

There has been considerable discussion of late among entomologists as to the best popular name for this insect. As was said in my former bulletin, "its common name, Forest Tent Caterpillar, is not very satisfactory, because, first, the insects are as likely to be found in apple orchards as in forests; and, second, they do not make tents in the complete sense that the

FIG. 45.—Caterpillars feeding upon Elm Leaves.

nearly-related American Tent Caterpillar does." Various substitutes for this name have been recently proposed, none of which, however, seem to me sufficiently satisfactory to warrant a change. Mr. M. V. Slingerland of New York has proposed that the insect be called the Forest Tentless Caterpillar, but the objections to this are, first, that it is not absolutely a tentless caterpillar, many of the caterpillars making in early life miniature tents, like the one shown on the title page of this bulletin; and, second, as Dr. L. O. Howard has pointed out, there are a great many other tentless caterpillars that feed upon forest trees.

DESCRIPTION OF THE LIFE STAGES

Egg.—The egg mass of this Forest Caterpillar is in the form of a belt encircling the smaller twigs of the various food-plants. Its general shape is represented in Fig. 46, the length of the belt varying from one fourth to one half of an inch; the diameter is usually one fourth of an inch. The belt terminates abruptly at each end, although it is not as a rule squared off. The outside of the belt consists of a glistening, varnish-like, brownish or lead-gray material, which covers the eggs. When the eggs are first laid, and for some months afterward, this covering remains entire, but as the winter passes it becomes more and more broken, so that by spring it generally has a rather ragged appearance. By removing the covering the eggs will be found beneath, resting side by side at right angles to the supporting twig. Each egg is a trifle longer than wide, and is covered with a reticulated network of the same varnish-like material that conceals the mass as a whole; this network serves to attach the eggs to the twig and to each other. The eggs are of a dull gray color, showing white in some places. When the caterpillars hatch they gnaw off a circular cap on the upper end of the egg, and come out through the hole thus made. Each egg is about one twentieth of an inch long. The number of eggs in one belt varies from less than 150 to more than 225, the average being nearly 200. When the insects are so abundant that there is a partial exhaustion of the food supply of the caterpillars, the normal number of eggs are not laid, the egg rings being much smaller than usual.

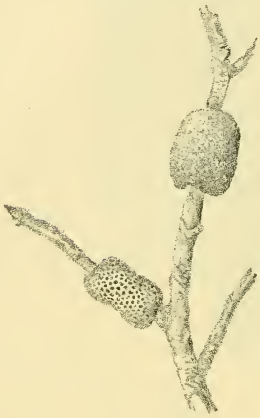

FIG. 46.—Egg Masses.

Larva.—The full-grown Forest Caterpillar is about two inches long and about one fourth of an inch thick. In shape it is cylindrical, with six jointed legs arranged in pairs directly back of the head, eight thick prolegs along the middle, and

two prolegs at the head end of the body. The head is dark bluish, and the body in general has a bluish appearance, more or less modified by the longitudinal series of marks and stripes. Along the middle of the back there is a series of whitish or cream-colored marks of the shape shown in Fig. 47 *a*. Along

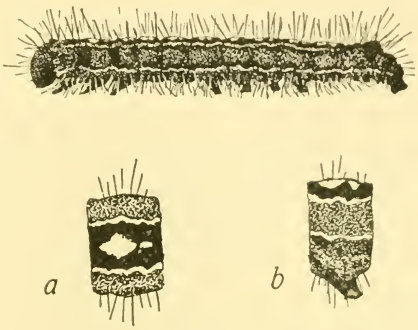

FIG. 47.—Forest Tent Caterpillar; *a*, markings on one ring of the back; *b*, markings on one ring of the side.

the upper part of each side there is a broad blue stripe, bordered above and below by a narrow, irregular, yellowish-white line. On the lower surface the color is bluish black. The whole body is sparsely clothed with rather short hairs.

Cocoon.—When the cocoon is not made within a leaf the loose outer silk varies greatly in the area occupied. An average size would be about one and three-fourths inch long by one inch wide. The inner firmer part of the cocoon is generally a little less than one and one-fourth inch long by one-half inch wide. The inner cocoon is colored yellow by the material voided by the caterpillars just before pupation, but the outer fluffy silk is generally white, because it is not reached by the yellow liquid. As already stated in a previous paragraph, when the cocoon is made within a leaf its outer appearance varies greatly, according to the material employed.

Pupa.—The pupa is the dull brown, mummy-like object to be found within the cocoon. It has neither legs nor wings, and is unable to move otherwise than by a wriggling motion of its body. The pupa that is to develop into a female moth

is larger than that of the male. The sizes are approximately as follows: Male, length three-fourth inch, width five-sixteenth inch; female, length nine-tenth inch, width three-eighth inch. The pupa is commonly more or less covered with the light yellow powder which gives the cocoon its yellow color.

Moth.—The male moth (Fig. 44 *a*) is considerably smaller than the female (Fig. 44 *b*). The former has a wing expanse of one and one-fourth inches, while the latter expands one and one-half inches. Both are light buff-brown, the color of the male being considerably deeper than that of the female. Along the middle of the front wings there is an oblique darker band, as shown in the figures. The feelers or antennæ of both sexes are feathery, but those of the male are much broader as well as somewhat longer.

BIRD ENEMIES OF THE CATERPILLARS

In Bulletin 64 mention was made of many sorts of birds that feed upon these insects. During last season these feathered allies continued their good work. Under date of June 26, Miss Soule wrote from Brandon, Vt.: "I am almost sure that the caterpillar has drawn the birds here, for in four summers I have never seen nearly so many as this year, though I have been observing birds for years. Too much cannot be said for the birds. The orioles and the redwinged blackbirds especially are stripping the trees of pupæ. Yesterday I saw orioles at work on a beech and an oak that had been badly eaten at the top, and I pulled down some of the branches and examined each of the many cocoons. Every one had the neat slit these birds make, and every pupa was gone. The baby orioles all learn to do this as soon as they can fly from one twig to another." A little later cedar birds were seen flocking to the trees, opening cocoons and devouring the pupæ. On July 8, Miss Soule wrote: "The number of birds is really amazing, and the thorough work they do is delightful." Regarding the birds that eat the moths, the same keen observer, in an admirable article in the *Springfield Republican*, said: "Many cocoons gave the moths in July, and these little brown moths could be seen in great numbers flying about the maple,

elm, apple, pear, ash, and other trees, laying their eggs near the tips of the twigs,—flying by daylight. Then the birds had another feast. Vireos of four kinds, fly-catchers of three kinds, both cuckoos, robins, rose-breasted grosbeaks, tanagers, cedar-birds, cat-birds, orioles, redwinged blackbirds, martins, and sparrows fed on the moths as they had done on the pupæ and larvæ. Chipping sparrows became expert 'lofty tumblers' in

FIG. 48.—Apple Leaves, partially eaten; one showing cocoon.

their zigzag pursuit of the flying moths, and even the English sparrows had a brief season of usefulness, for they really ate some of these moths, though they would not touch either pupæ or larvæ."

The Baltimore orioles were among the most efficient enemies of the caterpillars, destroying them in great numbers for their own food as well as to feed their young. These orioles are exceedingly useful birds, as they generally feed freely upon

FIG. 49.—Baltimore Oriole attacking nest of American Tent Caterpillar.

hairy caterpillars, being among the most destructive enemies of the common American Tent Caterpillar. (Fig. 49.) They should be encouraged to nest and remain about the farm and garden.

INSECT PARASITES

The most numerous parasites of these caterpillars were the small two-winged flies called Tachina flies. At least three species[1] of these friendly insects were destroying the hosts of caterpillars. One of these flies is represented somewhat mag-

[1] The three species were kindly determined by the Entomological Division of the U. S. Department of Agriculture as *Tachina mella* Walk., *Exorista futilis* O. S., *Frontina frenchii* Will.

nified in Fig. 50 *a*. It looks much like a common house-fly, and is of about the same size. This fly deposits a whitish egg upon the skin of the caterpillar, generally after it is more than half-grown. The egg soon develops into a tiny grub that burrows through the egg-shell and the skin of the caterpillar into the inside of the body. There it remains, absorbing the tissues of its host, and gradually increasing in size. In due time it becomes fully developed in this grub state, and breaks through the skin of the caterpillar. It is then a good-sized, white, oval, footless grub. The caterpillar has generally spun its cocoon before the parasite comes from its body, so that the parasite finds itself inside the cocoon when it gets outside the caterpillar. The grubs of two species of these Tachinid parasites work their way through the cocoon and drop to the ground, while the other seems to remain in the cocoon.

b *a*

FIG. 50.—Tachinid Parasite of Forest Tent Caterpillar: *a*, fly; *b*, puparium.

The parasitic larvæ have now to enter upon the quiet pupa stage. For this purpose the outer skin turns brown, and becomes hard, forming a protective covering for the insect inside. This is called the *puparium* (Fig. 50 *b*). Within this covering the insect changes to a pupa, to change again about two weeks later into an adult fly.

These parasites were very abundant last season, and are, doubtless, one of the most efficient checks upon the caterpillars. In some localities they seem to have nearly brought the outbreak to an end, and it is probable that they will do still more good this year. A correspondent at Campton, N. H., writes that in June great numbers of strange flies were seen in the woods and pastures. They were probably these tachinids.

The Ichneumon flies of the genus Pimpla[1] also did good service in destroying the caterpillars. The adult is a four-winged fly that deposits eggs in the caterpillars or newly-formed chrysa-

[1] *Pimpla conquisitor* was the most abundant species; a few *P. pedalis* were also reared.

lis after the cocoons are spun. The method of egg-laying is shown in Fig. 51. The eggs hatch into minute grubs that develop at the expense of the chyrsalis, finally eating up nearly all their substance. About two weeks from the time the eggs are laid the parasitic larvæ change to pupæ, and very soon afterwards again change to adults.

FIG. 51.—Ichneumon fly depositing an egg within cocoon. (Slightly magnified.)

Two other small parasites of the Chalcid family were also reared, although they were not at all abundant. One of these was the species called by entomologists *Diglochia omnivorus*, while the other has not been determined. We have also reared one species of parasite from the eggs of the Forest Tent Caterpillars.

BACTERIAL DISEASES

It is a well-known fact that seasons of dry weather are favorable to the development of insects injurious to plant life. This is especially true of caterpillars, and so the extraordinary dryness of the spring and summer of 1899 was very favorable to the increase of the Forest Tent Caterpillars. Their various bird and insect enemies did good service in destroying them, but the bacterial diseases that are likely to affect such insects during wet seasons did them little harm. The recent outbreak of the common American Tent Caterpillar was brought to an end two years ago chiefly through the agency of such a disease, the wet weather being favorable to it.

These bacterial and fungus diseases have been present, to a limited extent, among these caterpillars, both last year and the year before. Should next June be a very wet month, these diseases would probably do much to check the outbreak.

USELESS REMEDIAL MEASURES

As is always the case when a little-known insect becomes destructively abundant, a great many useless remedies for these caterpillars have been proposed. One of the most foolish of these is the insertion of sulphur in the trees in holes bored by an auger—a time honored fake that has, at various times, been proposed for all the ills that trees are heir to. Kerosene has also been applied to bands around the trees, greatly to the injury of the latter, as the kerosene soaks into the sapwood and kills the tree. The authorities of one Vermont town "sprayed many trees with a mixture of kerosene, Paris green, and soapsuds, which burned the leaves very badly and seemed to injure the trees." Such measures are usually the result of ignorance.

SUCCESSFUL REMEDIAL MEASURES

In Bulletin 64 I printed a summary of the remedial measures, which, after a careful study of the insect, seemed likely to be useful. As I then wrote, the practical value of most of these measures depends largely upon the conditions under which they are to be applied. A suggestion that is easily applicable to a few small trees in an apple orchard may be wholly inapplicable to the larger trees in a woodland. The abundance of the caterpillars, the nature and number of the trees infested, the season of the year, and the means at hand are all to be taken into consideration.

In the paragraphs below I have revised these directions by incorporating the knowledge which the past season's experience with the pest has given, from our own observations as well as from those of the various correspondents who replied to the circulars sent out.

Egg destruction.—There seems to me no reason for modifying the statements made under this heading in Bulletin 64, except to emphasize the fact that this method is not at all practical in cases of serious infestation. On a bright day, when the trees are bare of leaves, egg-masses may be easily seen. The cutting off and burning of these masses is often

practicable in a young apple-orchard, although it is generally considered impracticable in orchards of large trees. It generally would be out of the question in woodlands, of course, although in case of a few ornamental maples or other trees on the home grounds such egg-collecting might well be worth while. The gathering may be done by sending a sharp-eyed boy into the trees to cut or rub off the glistening masses, or by means of a pruning hook or a pair of long-handled pruning shears. The belts of eggs should be burned after they are gathered. When the insects are abundant these egg masses are so thick that to cut them off one must cut off nearly all the twigs—a ruinous proceeding. In such cases it is better to spray with arsenate of lead.

Killing the young caterpillars.—On small trees, where the caterpillars are easily reached, something may be accomplished by swabbing the colonies of young larvæ when at rest by means of a bunch of cotton waste, old rags, or something similar. In rainy weather one is more likely to find the larvæ massed together during the day than in bright weather.

Use of water.—One of the easiest ways of knocking the caterpillars off the trees is by the use of a forcible stream of water from a hydrant or good force pump. In Hanover the town authorities used streams from the hydrants with an eleven-sixteenth-inch nozzle from the fire service to good effect in clearing the caterpillars from the magnificent elms of that beautiful village, and the same method has been successfully used in various other places. Of course the caterpillars that fall to the ground are to be destroyed, or at least prevented from again ascending the trees. The Hanover authorities washed the trees from two to four times. The trees were banded, so that those caterpillars which were not crushed on the ground immediately after falling were prevented from ascending the trees, and destroyed when they congregated on the bark below the bands. It would be well worth while to try this washing method in early spring, just after the caterpillars hatch and before the leaves expand.

Spraying with poisons.—The season's experience has shown that spraying with arsenical poisons is a practical and

effective remedy against these caterpillars, especially in apple orchards and on comparatively small shade trees. On larger trees it is simply a question of reaching the foliage with the spray. The chief drawback in the use of Paris green—the commonest of these insecticides—is the danger of scorching the foliage. In this respect the arsenate of lead is much safer, as it does not injure the foliage at all. When Bulletin 64 was published this substance was not upon the market, and consequently had to be prepared by the user. It is now obtainable, however, from Wm. H. Swift & Co., 75 Broad street, Boston, Mass., who manufacture it in quantity, and offer it for sale in wooden packages at from fifteen to eighteen cents per pound. It is also for sale by the Bowker Chemical Company, 43 Chatham St., Boston, Mass. This is cheaper than Paris green at the prices the latter has recently sold for. The arsenate of lead is said to remain on the tree longer than Paris green. It is a white powder and a deadly poison, so that great care should be taken not to leave it around where it might be mistaken for something else, or where it might be reached by children or stock. Spraying with arsenical mixtures is most effective when it is done before the caterpillars are one-fourth grown. It should certainly be done before they are half grown. Later than this it is comparatively ineffective.

Banding to prevent invasion.—In case of an uninfested apple orchard in the vicinity of an infested woodland, it will be advisable to band the apple trees with cotton or raupenleim before the caterpillars are half grown, to prevent invasion from them. The same advice would hold in the case of other uninfested trees in the vicinity of those infested.

Banding the tree-trunks.—The remedial measure that has been most generally employed is that of banding the trees with some substance to prevent the ascent of the caterpillars. It has already been pointed out that a large proportion of the caterpillars drop off the trees from one cause or another, and have in consequence to ascend the same or neighboring trees in order to reach the leaves. The placing of some substance around the trunk to prevent the upward progress of the insects

causes them to congregate below the band, where they are easily reached and destroyed. The commonest material employed for this purpose seems to have been ordinary cotton batting, tied around the trunk of the tree. This is cheap, and answers the purpose very well. Various mechanical barriers have also been employed with more or less success, such as bands of hemp, tin, and tarred paper. In some cases correspondents reported that tar or kerosene was poured upon the cotton. The use of kerosene in this way is not to be commended, because of the danger that it may kill young and thin-barked trees by being absorbed through the outer bark to the sapwood beneath.

Another sort of these barriers is found in the various viscid substances with which the trees have been banded. These prevent the progress of the caterpillars either by killing them through contact as they attempt to cross, or by smearing their legs in such a way that they turn around as soon as they come upon it. The materials of this sort that have been used most are lard, cottolene, sticky fly-paper, printers' ink, tar, and "raupenleim," or caterpillar lime. In many places rancid lard or cottolene was used in considerable quantities, being smeared around the trunk of the tree in a band about six to ten inches wide. While this substance does not penetrate through the outer bark of large elm trees, it should be understood that there is danger in its use upon young, smooth-barked trees, on account of the probability that the oil will penetrate to the sapwood. Printers' ink seems to answer very well, as does the sticky fly-paper until it is injured by rains. The raupenleim, or German caterpillar lime, recommended in my first bulletin on this insect, has been tried in several localities, and has given very satisfactory results. A material similar to raupenleim is now offered by the Bowker Chemical Company, Boston, Mass., under the name "Bodlime." It should be removed from the tree after danger from insects is past.

On the whole, cotton seems to be the most advisable material to use for banding the trees. It is not expensive; every one can get it; it can be applied to all sorts and sizes of trees with little trouble, and with no danger to the tree. In case the

caterpillars are very abundant, two bands might be used, one a foot or two above the other. It is simply to be tied around the trunk of the tree with a stout string. If frequent rains render the outside compact and useless, it can easily be taken off and reversed, or a little new cotton added to it.

Killing the caterpillars.—Of course the caterpillars that congregate below the bands are to be destroyed. The simplest way to do this is by the use of a stiff broom. This or some similar method is also to be used whenever the caterpillars appear upon the tree trunk in sufficient numbers.

After the caterpillars are half grown, they commonly come down to the lower branches or the trunk to undergo the moulting process. To this end they gather in great masses on the bark, where they may be destroyed as suggested, or by collecting the caterpillars in pails containing a little kerosene and water. Vast numbers of the caterpillars have been destroyed in these ways in New Hampshire during the last two years.

Jarring and banding.—It has already been stated that these caterpillars drop downward when disturbed, breaking the fall by means of a thread spun from the mouth; although when young and suddenly jarred apparently the thread may not be used. This habit leads to the suggestion that by a combination of jarring and banding much injury may be prevented, at least in the apple orchard and on the home grounds, and especially on small trees. After the trees infested have been banded, a boy with a padded mallet may be sent into them with instructions to jar the limbs on which the caterpillars are working, beginning at the top. This should be done when the caterpillars are feeding upon the leaves, as they are then much more easily disturbed than when they are at rest. Of course it is not to be expected that going over once will wholly rid the tree, but by two or three repetitions of the jarring most of the caterpillars should be removed. A sheet of cloth may be spread beneath the tree to catch the caterpillars as they fall, or a light roller might be run over the ground to crush them. Those which escape destruction will congregate in masses upon the trunk, below the bands, where they may be

destroyed by use of a stiff broom or by various other methods. The earlier this is done after the larvæ are all hatched the less will be the injury to the foliage.

The masses of caterpillars below the bands are sometimes killed by pouring on kerosene. If this method is employed, great care should be taken not to add enough to saturate the bark. Many trees have been killed by carelessness in such use of kerosene.

Collecting cocoons.—A large proportion of the cocoons are commonly spun where they can be reached. The destruction of these will lessen the number of moths that lay eggs for the next season's brood of caterpillars, although it will also lead to the destruction of large numbers of parasites.

This collecting of the cocoons has been done extensively in certain towns. In Hanover and Claremont the selectmen offered a reward of five cents per hundred cocoons, and in the former town 80,000 cocoons were collected and destroyed. The poster gotten out by the Claremont authorities is reproduced on the opposite page.

The chief objection to this method is that it leads to the destruction of large numbers of parasites. The proportion of parasites to moths is likely to vary considerably in different localities. Our observations indicate that at Claremont, last season (1899), about 30 per cent. of the pupæ were parasitized, while at Brandon, Vt., more than 40 per cent. were parasitized. Now these parasites are Nature's means of checking the outbreaks of this Forest Caterpillar, and it seems unfortunate that in destroying our foes we should also destroy our friends. It must be borne in mind, however, that any parasite found in these cocoons will not take effect upon next year's brood of caterpillars until they have completed their growth and done the damage, so that as regards the next season alone it is better to destroy the pupæ, even if some of the parasites are destroyed at the same time.

A simple method, however, may be adopted by which the moths may be destroyed and most of the parasites saved to continue their good work. It was first suggested to me by Mr. Fiske. Select a piece of shaded grassland, which is not

BOUNTY

ON

CATERPILLARS!!

The Selectmen of Claremont will pay Five Cents a Quart for this year's Cocoons of the Forest Tent Caterpillar, gathered in Claremont, during the next ten days.

Cocoons must be delivered at the Selectmen's Room, Town Hall, between the hours of 5 and 6 in the afternoon of any week day during said time

There is the utmost need that the public should awake to the danger that threatens the trees from this pest. The destruction of woodland and of shade trees seems imminent unless some way of killing the caterpillars is devised. At the present time this year's caterpillars are beginning to go into cocoons. They remain in this state about ten days, when a moth is hatched from the cocoon. This moth lays from 200 to 300 eggs, each of which becomes a caterpillar to ravage the trees next summer.

Let all good citizens understand that each cocoon is a source of very great injury: and that every cocoon destroyed will aid in the preservation of trees which cannot be spared.

Let young and old join in the work of gathering cocoons. It is for the direct benefit of the town that this should be done.

A. C. STONE,
C. A. FISHER,
W. T. FREEMAN,
Selectmen of Claremont.

Claremont, N. H., June 20, 1899.

Facsimile of hand-bill offering bounty for cocoons.

much tramped upon by people or animals, scatter over this the cocoons as they are collected, not making the layer more than an inch deep; leave the cocoons in this position until the moths begin to emerge; then rake the cocoons up and burn them. During the week or ten days that the cocoons remain here most of the parasites will have left them and found shelter in the turf, where they will complete their development. By keeping two or three hundred cocoons in a box under observation, the time when the first moths come out can be readily determined.